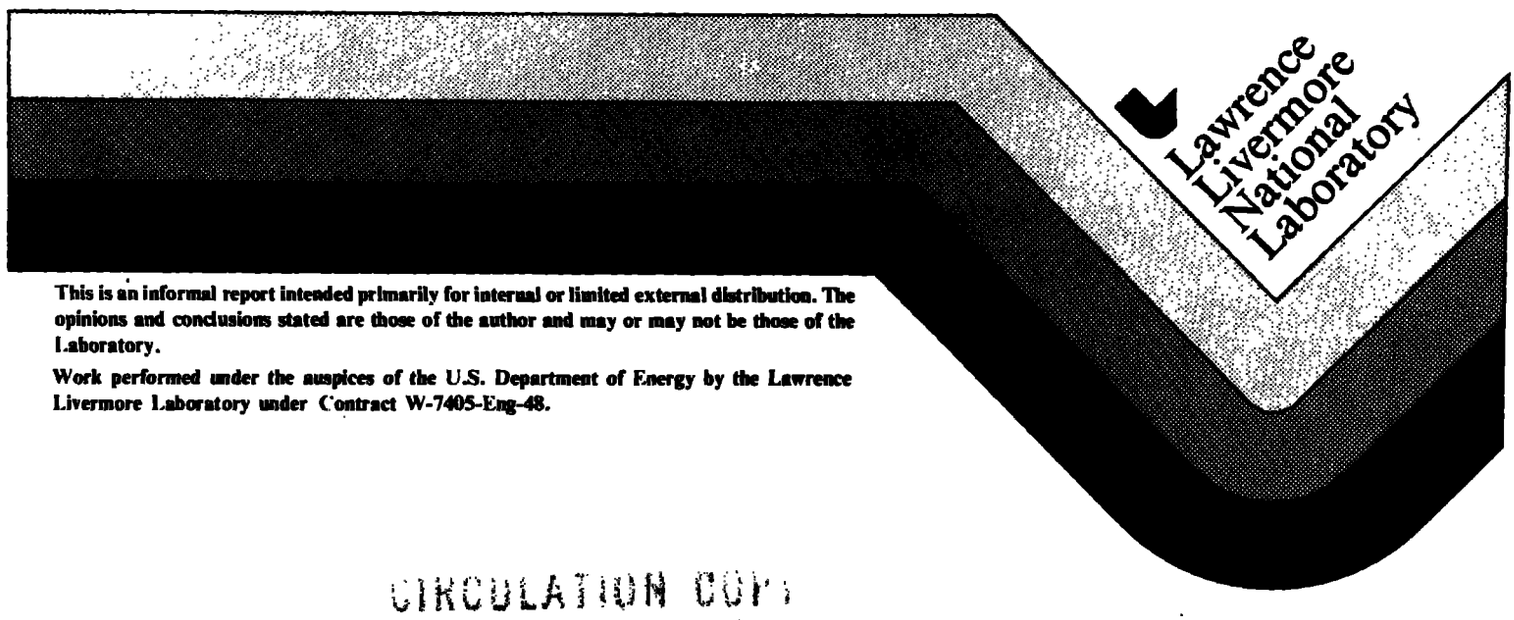
UCID-20158

Safety Evaluation Of A New Proposed Standard Laboratory Coat

Albert J. Pane

July 1984



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1. Introduction

A new disposible laboratory coat has been proposed for use at the Lawrence Livermore National Laboratory. The coat is disposable by incineration and therefore doesn't need laundering. Laundry workers would therefore not be exposed to unknown potential carcinogenic toxic and radioactive materials.

I was asked to devise and run a series of safety tests on samples of the new lab coat, keeping in mind the protection the present coats offer. I ran the tests on samples of the proposed coat and also on samples of the coat now in use. A direct comparison was made between the two fabrics by observation and direct measurement.

The original tests suggested included the following:

1. Flame (match)
2. Fire (a continuous flame)
3. Acids
4. Bases
5. Solvents
6. Exploding Glass

In addition to those above, I added the following:

7. Allergic reactions
8. Protection from fine dust
9. Tensile and tearing tests on the two fabrics

2. General Information About The Two Coats

A. The Coat in Present Use

The laboratory coat in present use is made of a woven fabric which consists of 65% Polyester and 35% Cotton.

The coat is white with the hem hanging slightly below the knees. The coat is fastened with buttons on the front.

The test patches used in tests were from a new coat checked out of stores. The acronym "Prescoat" is used to identify the current lab coat in the following tests.

Figure #1 shows a micrograph of the woven pattern of the "Prescoat" enlarged X10.

The weight of the coat as received was about 400 grams. A test patch 4"x4" weighs about 1.74 grams.

Photomicrograph X10

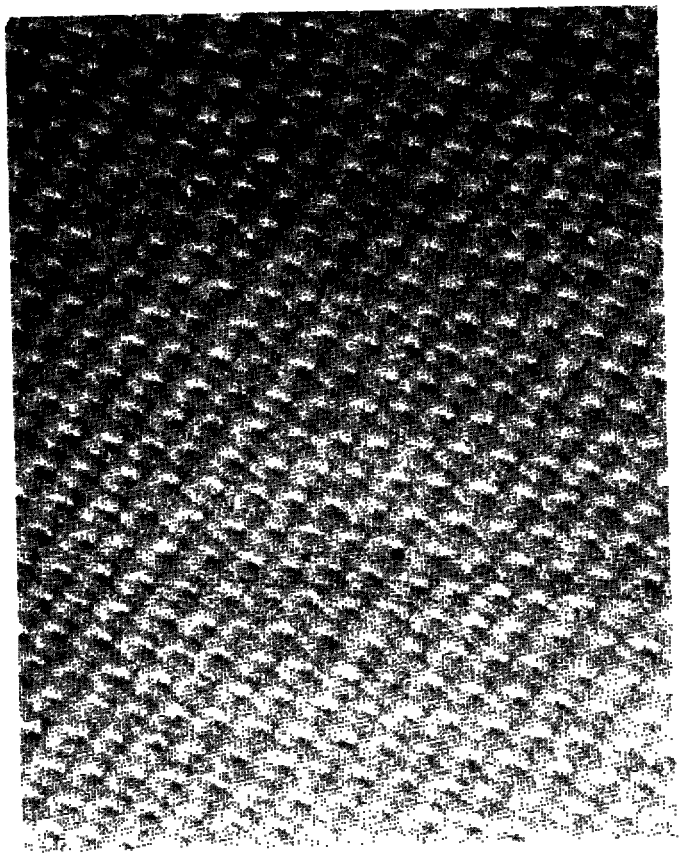

Figure 1. "Prescoat" Weave

B. Proposed Laboratory Coat

The proposed coat is made of pressed cotton fibers[1]. Additives provide bonding of fibers and fire-retardition properties. (A copy of the Infra-Red Analysis is attached at the end of the report). This material is available as both a standard lab coat and a jump suit for shop work. The material tested came from a jumpsuit version. For identification in this text an acronym has been adopted here to label the proposed laboratory coat: "Procoat".

Figure #2 is a photomicrograph of a test sample of the pressed fabric enlarged X10.

The weight of the jumpsuit as received weighed 258 grams. A test patch 4"x4" weighed 0.87 grams.

3. Allergic Reactions

Most workers in the laboratories wear the coats about 8 hours during the day. The fabric touches the human skin on the neckline and on the arms and wrists. To date there has been no skin allergies attributed to the coat in present use.

Four subjects were asked to wear a test coil of the pressed fabric from the "Procoat" directly around their wrists under their watches.

Results:

Subject	Hours Exposure	Reaction
A	24	No allergy
B	24	No allergy
C[2]	30	Very slight itching
D	48	No allergy

[1] This disposable laboratory coat is available from Pedley Knowles and Co., Safety Sivision, 1300 Illinois Street, San Francisco, CA 94107. The coats cost $4.70 each and are available in white and blue colors, the standard small,medium, large, etc sizes and models with different pocket locations.

[2]Subject C was known to have an extremely sensitive skin.

Photomicrograph X10

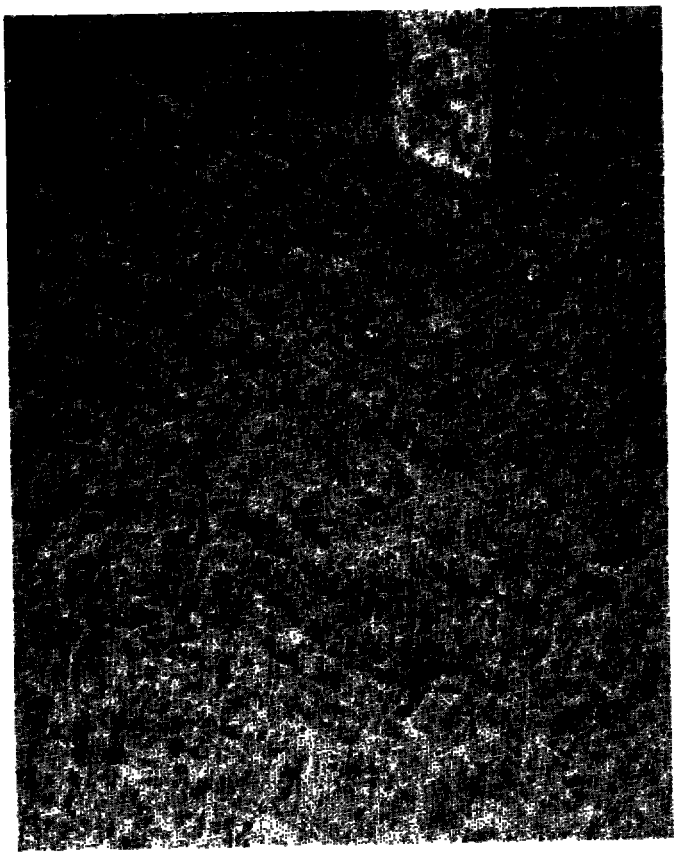

Figure 2. "Procoat" Texture.

4. Flame Tests

A. Match Test

One 1/2" x 6" strip of each fabric was suspended in air. Each strip was ignited with a match.

Results:

The "prescoat" strip ignited. When the match was withdrawn, the flame completely consumed the strip.

The "procoat" on application of the lighted match started to burn, char and wrinkle. When the match was withdrawn the strip self-extinguished the flame.

B. Flaming Solvent Test

A 4"x4" test patch of each fabric was placed on a perforated desicator plate and 2 c.c. of ethanol was soaked into the flat test patch and immediately ignited with a match.

Results:

The "prescoat" sample didn't ignite but charred around the edges and curled up a bit at the corners. A second application of ethanol and ignition with a match caused the patch to catch fire at the upturned corners and burn up completely.

The "procoat" on the two burnings just charred on the edges and basically remained intact.

C. An Oxidizing Flame Test

A 4"x4" test patch of each fabric was placed flat on a perforated desicator plate and an oxiding flame from a hand torch was continually applied to each patch.

Results:

Both fabrics were completed consumed by the flame and reduced to ash to 3 to 5 seconds.

5. Acid Tests

4"x4" test patches of both fabrics were used in this series of tests. 2 c.c of the acid were applied from a pipette allowing the droplets from the burette to spread over the entire patch.

Results:

A. H_2SO_4, 98%

"Prescoat": No immediate charring acid quickly soaked through the fabric. After 5 minutes the cloth started to turn black. In 15 minutes the cloth was turning to a viscous material with large holes appearing.

"Procoat": By the time the entire 2 c.c, of H_2SO_4 had empited from the pipette, a one inch hole was burned in the test patch. Entire surface of patch after one minute charred. Entire sample liquified thereafter.

B. Nitric Acid 70%

"Prescoat": Patch yellowed as HNO_3 entered into mesh. Acid soaked quickly into mesh. Although soaked in the acid for 1/2 hour, there was still strength in the cloth.

"Procoat": HNO_3 quickly soaked into patch. Patch weakened after 1/2 hour.

C. Hydrochloric Acid, 37%

"Prescoat": 2 c.c. acid soaked quickly into patch. No immediate effect. No appearant effect after 1/2 hour.

"Procoat": Ditto above. Color of patch turned from blue to a reddish color.

6. Caustic Test

This test was run similarly to the acid tests using 2 c.c. of caustic (50% N_aOH) on 4"x4" test patches.

Results:

No immediate effects. Droplets dispensed from burette hadn't spread in 1/2 hour. Cloth still intact after 12 hours. Most of water had evaporated leaving "droplets" of moist NaOH.

7. Solvent Tests

2 c.c. of each of the following solvents were added to 4"x4" test patches of both fabrics:

Ethanol
Acetone
Toluene
Choroform
Dimethylsulfoxide
Hexane

Results:

In general the solvents quickly permeated the holes of both fabrics but had no effect on them.

8. Dust Test

A piece of cloth (circular test patch) was fastened over a 3.5" plastic petri dish with a aeroseal clamp in much the same manner as one prepares cloth for embroidery. A small measured scoop of 600 grit boron carbide was placed on the test patch and was brushed back and forth on the patch for 5 minutes with an acid brush. Any material swept through the mesh of the fabric could be caught in the tared petri dish.

Results:

"Prescoat": The entire scoop, approximately 0.1 g went through the cloth into the petri dish in 2.5 minutes.

"Procoat": Powder remained on test patch after 5 minutes. No weighable amount of material had gone through the pressed fibers.

9. Mechanical Test

Samples of both fabrics were submitted to the Materials Test Laboratory of the Material Engineering Division for Tensile and Tear tests.

Results:

Figures given below are averages of three runs.

A. Tensile Strength

"Prescoat"	108 lbs/inch of width
"Procoat"	13 lbs/inch of width
"Procoat	7* lbs/inch of width

* A tranverse pull was made, a pull against the calendered direction, see Figure 2.

B. Tearing Strength

"Prescoat"	8.0 lbs/inch of width
"Procoat"	1.5 lbs/inch of width

10. Exploding Glass Test

A test device was designed and used to compare damage to the two fabrics from flying glass particles.

A schematic sketch of the apparatus is shown below:

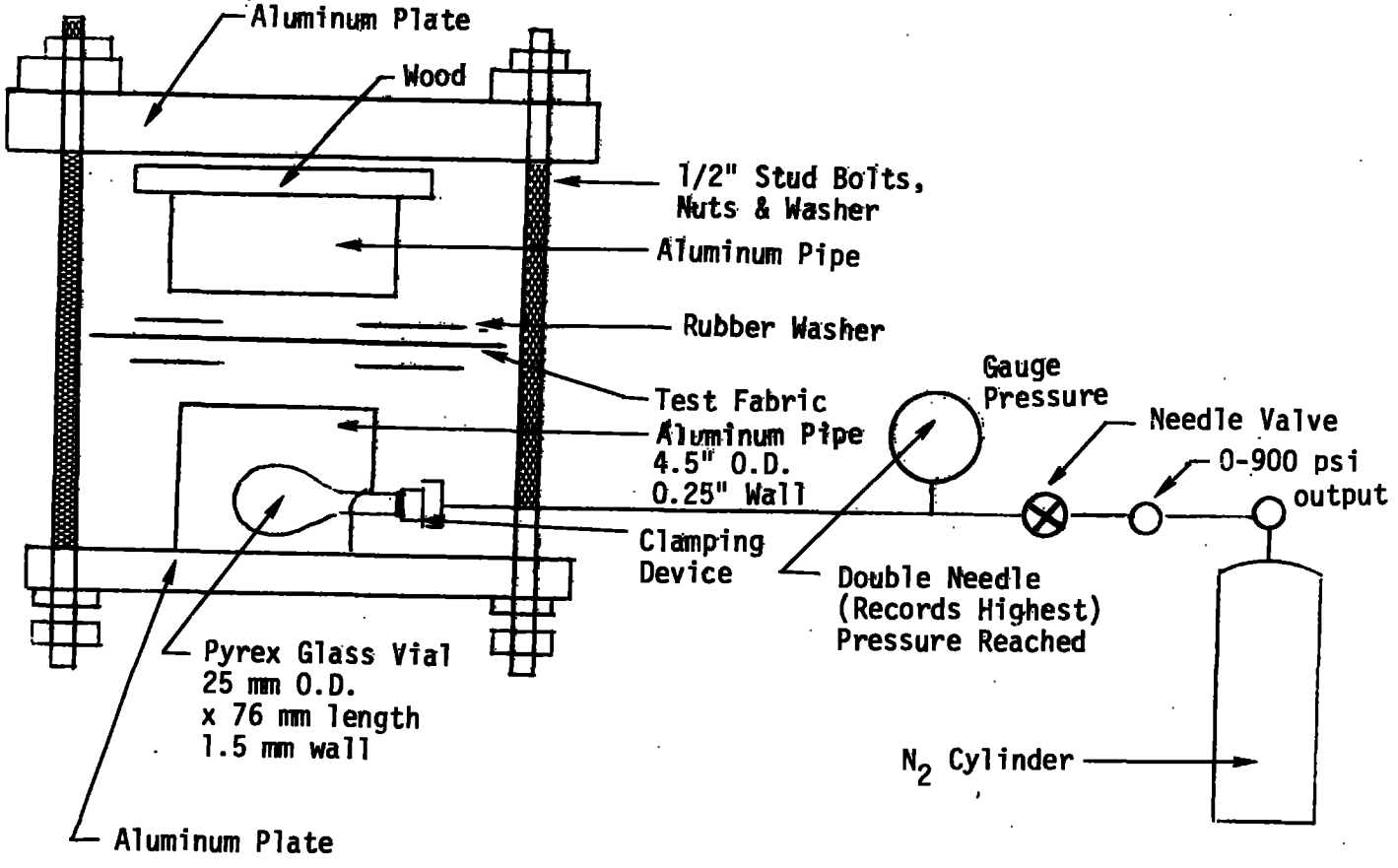

Figure 3. Schematic Sketch of Flying Glass Test Apparatus

The glass vials were hand made in our glass shop. They were oven annealed. In the first trial runs one vial burst at 600 psi but none of the other three vials tried burst even through the pressure was taken up to 850 psi. To make the vials burst at lower pressures, it was necessary to induce stresses in the glass using an oxygen-natural gas handtorch and flaming the vials in a random fashion.

Comparable runs were made at two heights (vertical distance at which the glass particles had to travel to hit the test patch). The heights were 12 inches and 2 inches.

Figure 4 & 5 shows the comparable damage sustained by each of the fabrics at a distance of 12 inches.

Figures 6 & 7 shows the comparable damage substained by each of the fabrics at a distance of 2 inches.

I was fortunate in hand annealing the two vials for use in the 2 inch tests. One vial burst at 436 psi and the other burst at 430 psi.

11. Conclusion and Discussion of Results

A. Four Very Positive Results For The Proposed Coat Were Observed.

I. The fabric in the proposed coat will not sustain burning either ignited by a match or flaming solvent. The pressed fabric is self-extinguishing.

II. The fabric in the proposed coat will not pass any appreciable amount of dust 600 grit or larger. This would protect the body from contacting D-38 oxide, beryllium oxide and many of the solid toxic materials as listed by Hazards Control, LLNL.

III. The tensile pull of the proposed coat is 13 pounds per inch of width compared with the present coat, pull of 108 pounds per inch of width. The tearing strength of the proposed coats is 1.5 pounds per inch of width while the figure for the present coat is 8.0 pounds per inch width. In lathe or mill operations, a person would have a better chance of getting out of the proposed garment before getting badly mangled than he would getting out of the present coat.

IV. If the coats were made in the same pattern, the proposed coat would be approximately 50% lighter to wear than the present coat. This fact is based on the weights of the 4"x4" test patches of both fabrics.

B. Standoffs Between The Two Fabrics

I. Acids

The two fabrics seem to soak up the concentrated acids readily. Sulfuric acid, 98% disintegrates both fabrics in a matter of a few minutes. Neither garment offers a great deal of protection.

II. Bases

50% Caustic doesn't penetrate into the fibers of the two fabrics, it just clings to the surface in small spheres. Dilute bases would penetrate both fabrics very quickly.

III. Solvents

A series of solvents were soaked into both fabrics. The solvents spread throughout the two fabrics rather quickly presenting a potential fire hazard. The fabrics were not attacked by these solvents. Neither garment would offer a great deal of protection from toxic liquids such as:

p-Dioxane
carbon disulfide
aniline
Hydrazine

IV. Allergies

Neither fabric creates any major problems.

C. A Very Negative Result For The Proposed Coat.

The flying glass test results especially at the 2 inch vertical travel tests clearly shows that the present coat offers a great deal more protection from exploding glass than does the proposed coat.

Flying Glass Test Result

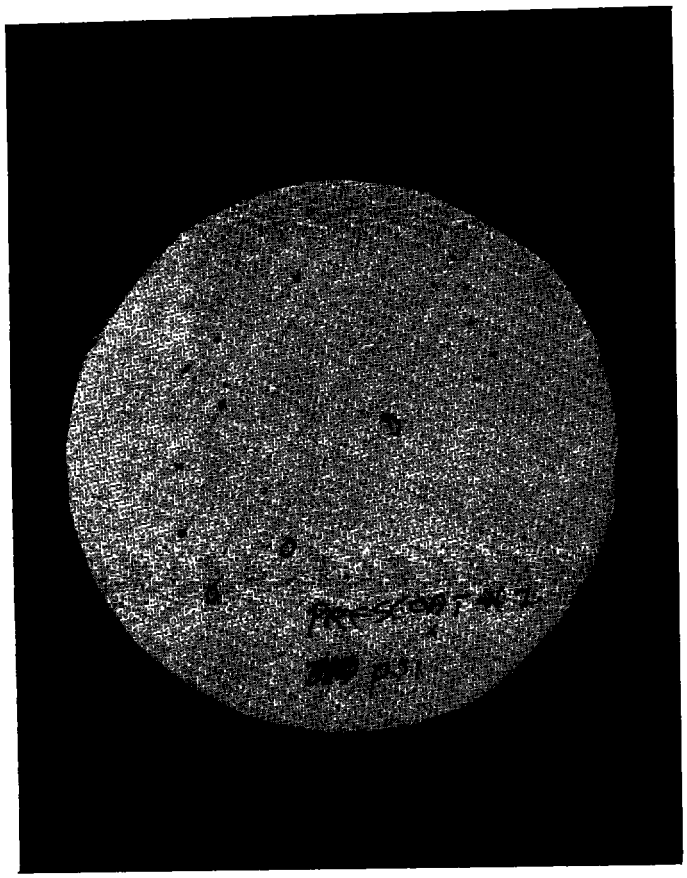

Figure 4. "Prescoat" Vial Burst @ 340 psi, @ 12 inches vertical travel.

Flying Glass Test Result

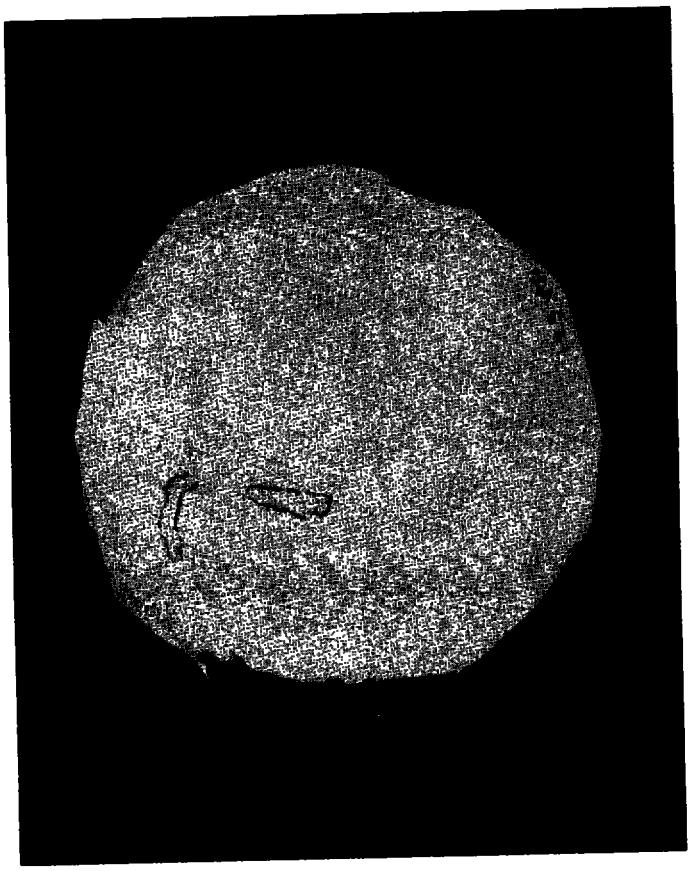

Figure 5. "Procoat" Vial Burst @ 125 psi, @ 12 inches vertical travel.

Flying Glass Test Result

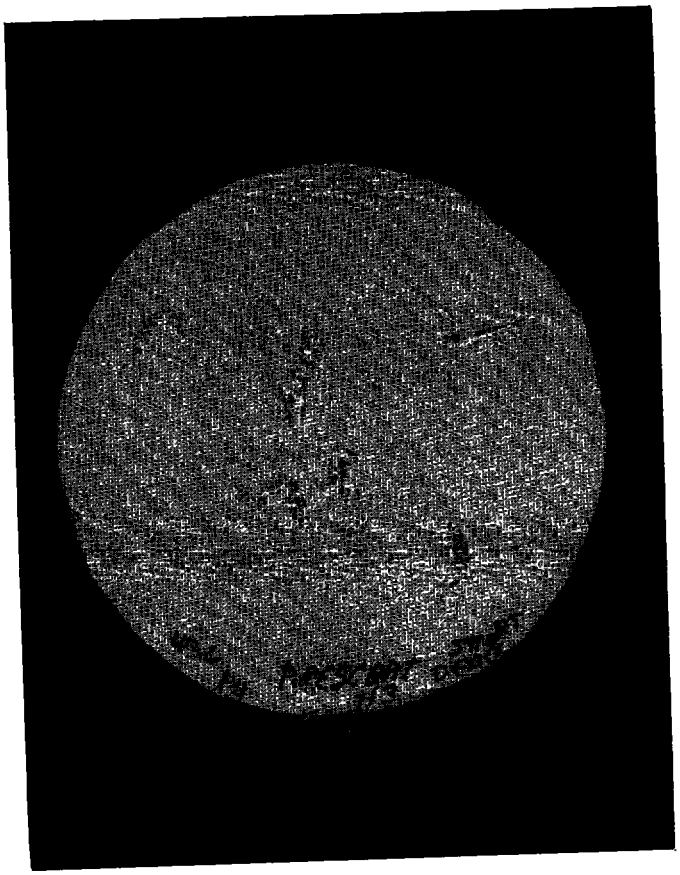

Figure 6. "Prescoat" Vial Burst @ 436 psi, @ 2 inches vertical travel.

Flying Glass Test Result

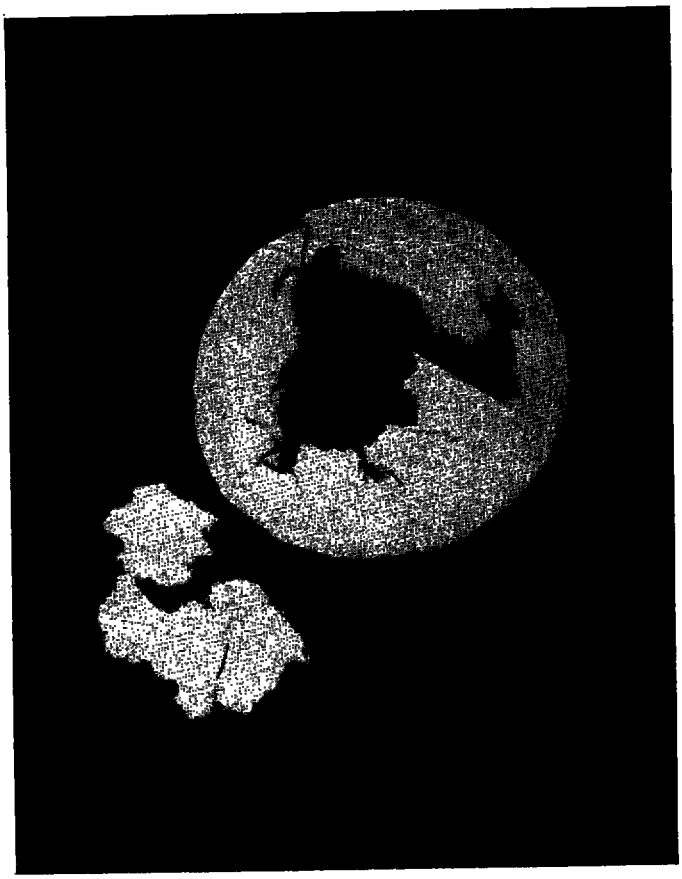

Figure 7. "Procoat" Vial @ 430 psi, @ 2 inches vertical travel.

Interdepartmental letterhead

Mail Station L- 310

Ext: 26356

May 10, 1984

M E M O

TO: A. Pane

FROM: R. Sanborn

SUBJECT: Analysis of Labcoat Material with GC/MS and IR Techniques

The labcoat material was examined directly and after extractions with methylene chloride and chloroform using the infrared Attenuated Total Reflection technique. The labcoat material is cotton, but may have undergone some treatment. The extractions, although not exhaustive, did not completely remove carbonyl groups from the material.

The methylene chloride (CH_2Cl_2) consisted basically of the binder, which is a complex adhesive derived from butadiene, acrylonitrile and a polyester. The mass spectrum obtained using the direct inlet probe had no distinctive features. This extract appears completely polymeric as nothing went through the GC capillary column.

A bromine based flame retardent was found in the chloroform extract. The mass spectrum of the white powder taken with the direct inlet probe shows mass fragments with up to seven (7) bromines. The IR spectrum snows in addition what might be an ester of boric acid.

Russ Sanborn

Russell Sanborn
Analytical Section
Chem. & Mat'l Sci. Dept.